FROM THE CHIEF SCIENTIST'S DESK

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Two-dimensional electron systems continue to reveal new science as researchers push the limits of experimental parameters to lower temperatures. A unique aspect of the NHMFL is its commitment to providing the extremes of parameter space, i.e., pressure, magnetic fields, and temperature. The success of the NHMFL High B/T Facility located at the University of Florida in Gainesville is an example of the laboratory's commitment to this objective.

New Results for Nearly Degenerate Quantum Phases in Two-Dimensional Electron Systems

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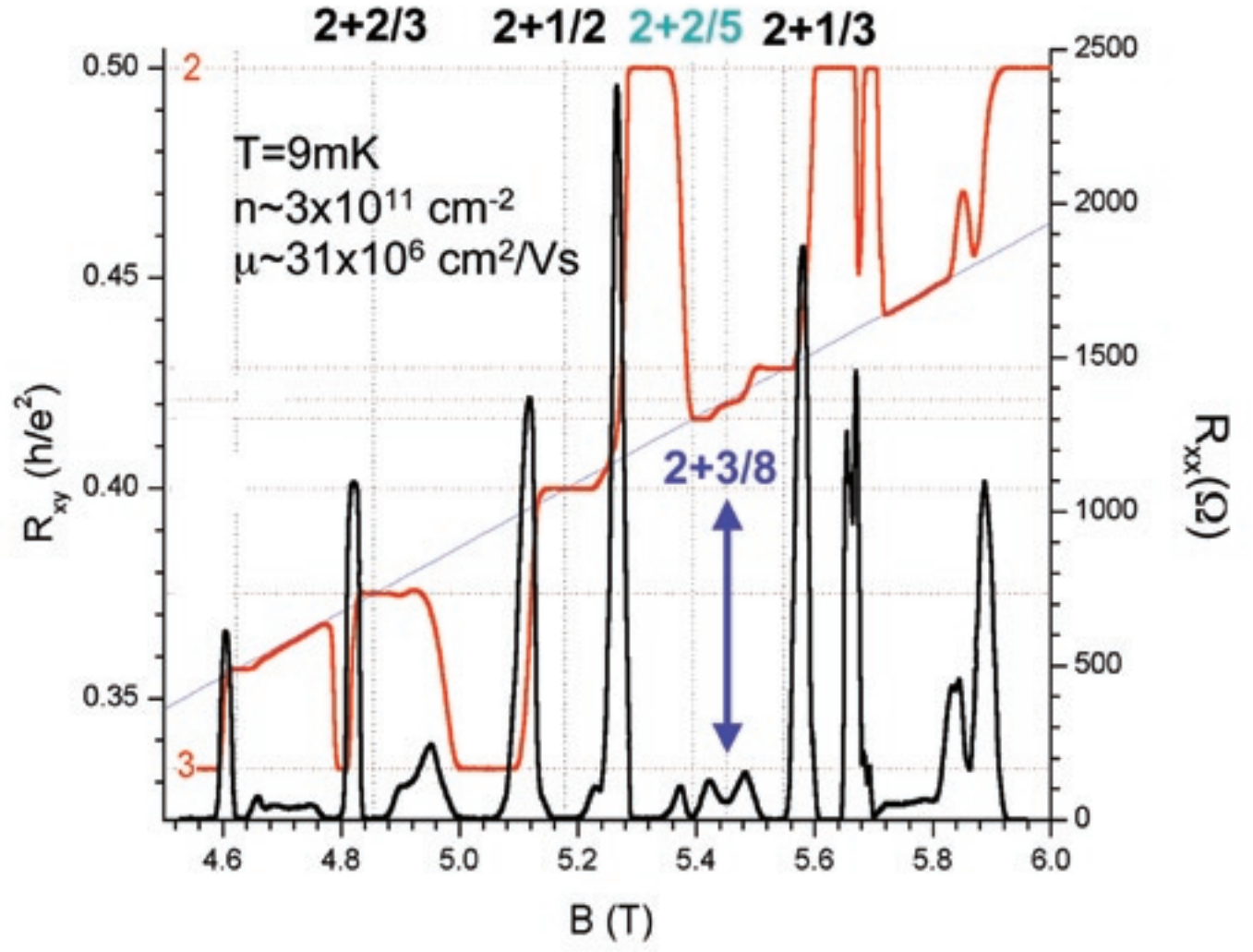
Interesting new results have been obtained from measurements of a two-dimensional electron system at the intersection of the region between the electron liquid state corresponding to the lowest Landau levels and the charge density wave or liquid crystal-like states at high Landau levels. The recent data was obtained at very low temperatures (sample temperatures as low as 9 mK) for a very high mobility 2D electron system. The results show strong evidence for new fractional quantum Hall effect (FQHE) states that compete with the reentrant integer quantum Hall effect (RIQHE) states.

The sample studied had an electron density of 3×10^{11} cm^{-2} with a mobility of 31×10^{6} cm^2/Vs. The measurements reveal well-quantized FQHE states at filling factors of $\nu = 2+1/2$, $2+1/3$, and $\nu = 2+2/3$ in coexistence with the RIQHE, and significantly a new FQHE state at $\nu = 2+2/5$. There is also evidence for a second even-denominator FQHE state at $\nu = 2+3/8$.



The figure shows the diagonal resistance and the hall resistance between filing factor ν=2 and 3 as measured at 9 mK. The most unusual feature is that the Hall trace of R_{xy} instead of moving monotonically from $h/3e^2$ to $h/2e^2$ returns to the value of the neighboring IQHE plateaus. These are the features expected for RIQHE states. Fully developed FQHE states are observed at ν= 2+1/2, 2+1/3, and 2+2/3, all with wide Hall plateaus. There is also a clear Hall plateau at ν=2+2/5 with a vanishingly small R_{xx}. A new even dominator FQHE state is appearing at ν=2+3/8.

From the temperature dependence of the new ν=2+2/5 state, one infers an energy gap of 70 mk. This is much smaller than that observed of the gap for ν= 2+1/3. The origin of the 2+2/5 state is not clear, as within the composite fermion model, the traditional 2+2/5 state is unstable, and numerical studies by Morf and d'Ambrumenil indicate that no hierarchical daughter state of the 2+1/3 state is stable between 2+2/3 and 2+1/3. The results strongly suggest that the new 2+2/5 state is not a conventional FQHE state.